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SUPER AUDIO CD

Super Audio CD System Description

Part 2 Audio Specification

Draft Version 1.3

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This document contains the differences with Part 2 Version 1.2 only.

SONY

PHILIPS

Super Audio CD System Description

Part 2: Audio Specification

Draft Version 1.3

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Philips Intellectual Property & Standards
Business Support
Building SFF-8
P.O. Box 80002
5600 JB Eindhoven
The Netherlands

Fax.: +31 40 27 32113
Internet: www.licensing.philips.com
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1.3 References and Conformance

Super Audio CD conforms to all mandatory requirements specified in this document. All parts in this document are mandatory unless they are specially defined as recommended or optional or informative.

Super Audio CD also conforms to the applicable parts of the System Descriptions or international standards that are listed below:

SACD Part 1	Scarlet Book Part 1. Super Audio CD System Description Part 1, Physical Specification, Royal Philips Electronics and Sony Corporation.
SACD Part 3	Scarlet Book Part 3. Super Audio CD System Description Part 3, Copy Protection Specification, Royal Philips Electronics and Sony Corporation.
CD-DA	Compact Disc Digital Audio, specified in the System Description Compact Disc Digital Audio ("Red Book"), Royal Philips Electronics and Sony Corporation.
IEC 908 / IEC 60908	Compact disc digital audio system.
ITU-R BS.775	Multi-channel stereophonic sound system with and without accompanying picture. ITU-R Recommendations BS Series. ITU-R BS.775-1.
ISO 9660	Information processing - volume and file structure of CD-ROM for information interchange. Ref. No. ISO 9660.
UDF	Universal Disk Format™ Specification. Published by OSTA, Optical Storage Technology Association, see www.osta.org .
ISO 639	Code for the representation of names of languages. Ref. No. ISO 639.
ISO 3901	Documentation - International Standard Recording Code (ISRC). Ref. No. ISO 3901.
ISO/IEC 646	Information technology - ISO 7-bit coded character set for information interchange. Ref. No. ISO/IEC 646.
ISO/IEC 2022	Information technology - Character code structure and extension techniques. Ref. No. ISO/IEC 2022.
ISO/IEC 8859-1	Information technology - 8-bit single-byte coded graphic character sets -- Part 1: Latin alphabet No. 1. Ref. No. ISO/IEC 8859-1.
BIG5	Big5 character set.
RIS 504	Online data exchange format for records. Published by Recording Industry Association of Japan.
RIS 506	Character set for records. Published by Recording Industry Association of Japan.
IEEE 1394	Standard for a High Performance Serial Bus. Ref. No. IEEE 1394-1995. Also see 1394 Trade Association, www.1394ta.org .

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1.4 Definitions

The following definitions are used in this specification.

Access List	The Access List is a table providing the relation between Time Code and Sector Address for a DST coded Audio Area.
Album	An Album consists of one or more discs. All discs in an Album must have the same Album_Catalog_Number (see chapter 3.1.1.2.3).
Audio Channel	The stream of DSD bits intended for one loudspeaker.
Audio Frame	A Frame containing Audio data.
Audio Channel Number	The sequence number assigned to an Audio Channel. Audio Channel Numbers are contiguously numbered starting with one.
Constant Byte Rate	The number of Sectors needed to store three Audio Frames is fixed.
Display Track	Display Track[n+Track_Offset] consists of Pause[n] and Track[n] and is used for display purposes.
Display Track Number	Display Track Number = Track Number + Track_Offset. Track_Offset is given in the Area TOC. The maximum value for Display Track Number is 510.
DSD	Direct Stream Digital, the one bit audio signal used on this specification. A DSD signal can either be DST Coded DSD, or Plain DSD.
DTCP	Digital Transmission Content Protection Specification Version 1.2, (Information Version), Volume 1. See www.dtcp.com .
EOS	End Of Sector.
Elementary Frame	An Audio Frame or a Supplementary Data Frame, or a Padding Frame.
Frame	A block of data belonging to a certain Time Code. The data can be either Audio Data, Supplementary Data, Padding or it can be Multiplexed. The playing time of a Frame is 1/75 Sec.
Hybrid Disc	A SACD disc with a high density layer and a CD-DA layer.
Index	A subdivision of a Track.
Index Number	An Index Number is the sequence number of an Index within a Track. The start position of Index one is equal to the start position of the Track. The maximum number of Indexes within a Track is 255.
LSN	Logical Sector Number, used to address the Sectors on the disc.
Multiplexed Frame	The part of the multiplexed stream belonging to a certain Time Code. See Frame.
Padding Frame	A Frame containing Padding data.
Pause	Area before the start of a Track. A Pause length of zero is allowed.

1.7.2.3 Genre4

The syntax of Genre4 is defined in Figure 1-6.

	# bytes	format
Genre4() {		
for (i=1; i<=4; i++) {		
Genre_Code[i]	4	Genre_Code
}		
}		

Figure 1-6 : Syntax of Genre4

If used, Genre_Code fields are available, they must start at i=1. The unused Genre_Code fields must follow the used Genre_Code fields.

1.7.2.4 Spec_Version

Spec_Version is a 2 byte number showing the version number of the format, used in this disc. The syntax of Spec_Version is defined in Figure 1-7.

	# bytes	format	value
Spec_Version() {			
Major_Version	1	UInt8	1
Minor_Version	1	UInt8	30
}			

Figure 1-7 : Syntax of Spec_Version

Major_Version must contain the major version number of this specification. Minor_Version must contain the minor version number of this specification. For discs according to this specification, Major_Version is equal to 1 and Minor_Version is equal to 30.

1.7.2.5 Special_Char

Special_Char is a text character with a length of one or two bytes, depending on the character set used for Special_Char.

1.7.2.6 Special_String

Special_String is a sequence of Special_Char one or two byte characters, terminated by a zero Special_Char. The syntax of Special_String is defined in Figure 1-8.

	# bytes	format	value
Special_String() {			
for (i=1; i<=n; i++) {			
Character[i]	1..2	Special_Char	
}			
Zero_Special_Char	1..2	Special_Char	0
}			

Figure 1-8 : Syntax of Special_String

All Characters in a Special_String must belong to one and the same character set. If the Characters are from a one byte character set, the length of Zero_Special_Char is one byte. If the Characters are from a two byte character set, the length of Zero_Special_Char is two bytes. A zero length Special_String is allowed. A zero length Special_String only contains a Zero_Special_Char.

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1.7.2.10.1 Text_Type

Text_Type gives the type of text encoded in this TOC_Text. The definition of Text_Type is given in Figure 1-14.

Value	Meaning
0	Reserved
1	Title
2	Name(s) of the performer(s)
3	Name(s) of the songwriter(s)
4	Name(s) of the composer(s)
5	Name(s) of the arranger(s)
6	Message(s) from the content provider and/or the artist
7	Extra message(s)
8	Copyright
9..127	Reserved
128	Reserved
129	Title, phonetic text
130	Name(s) of the performer(s), phonetic text
131	Name(s) of the songwriter(s), phonetic text
132	Name(s) of the composer(s), phonetic text
133	Name(s) of the arranger(s), phonetic text
134	Message(s) from the content provider and/or the artist, phonetic text
135	Extra message(s), phonetic text
136	Copyright, phonetic text
137..255	Reserved

Figure 1-14 : Definition of Text_Type

1.7.2.10.2 Padding1

The Padding1 field must contain one space character (\$ 20).

1.7.2.10.3 Sp_String

Sp_String contains the text information for the TOC_Text structure. The definition of Special_String is given in chapter 1.7.2.6.

1.7.2.10.4 Padding2

The Padding2 field must be used to adjust the length of the TOC_Text structure to a multiple of four bytes. All bytes in the Padding2 field must be set to zero.

1.7.2.11 Weblink_String

Weblink_String is a sequence of Char followed by a zero byte. A zero length Weblink_String is allowed. A zero length Weblink_String contains one Zero_Byte. The maximum length of Weblink_String is 128 bytes. The definition of Weblink_String is given in Figure 1-15.

	# bytes	format	value
Weblink_String(){ for (i=1; i<=n; i++){ Character[i] } Zero_Byte }	1	Char	
	1	UInt8	0

Figure 1-15 : Syntax of Weblink_String

An example of a valid Weblink_String is "http://www.weblink.net",0.

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2.2 Structure of the Volume Space

The Volume Space of a SACD disc is split into: File System Area, DTCP Area, Master TOC Area, 2-Channel Stereo Area, Multi Channel Area and Extra Data Area. The structure of the Volume Space is shown in Figure 2-3.

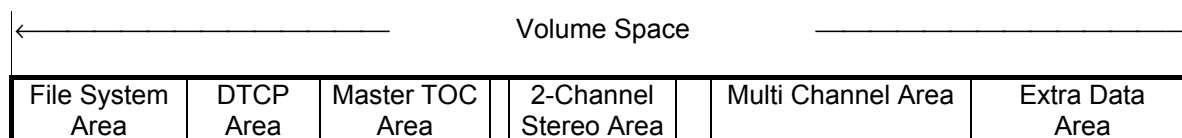


Figure 2-3 : Structure of the Volume Space

The 2-Channel Stereo Area and the Multi Channel Area are called Audio Areas. Every SACD disc must contain the Master TOC Area and minimally one Audio Area. The presence of the Extra Data Area is optional.

Gaps between the Master TOC Area, the 2-Channel Stereo Area and the Multi Channel Area are allowed. The content of all Sectors in the gaps must be set to zero.

2.2.1 File System Area

A SACD disc can optionally contain the ISO 9660 and/or the UDF file systems. The File System Area starts at LSN 0 and ends at LSN 399. It is recommended that all file system structures are stored in the File System Area. In case the File System Area is not big enough, additional file system structures can be stored in the Extra Data Area. The content of all not used sectors in the File System Area must be set to zero. If no file system is used, the content of all sectors in the File System Area must be set to zero.

2.2.2 DTCP Area

The DTCP area contains DTCP information, see chapter 3.3. The DTCP area starts at LSN 400 and has a length of 110 Sectors.

2.2.3 Master TOC Area

The Master TOC Area contains three identical copies of the Master TOC. The Master TOC describes the High Density layer of a SACD. The three instances of the Master TOC are stored starting at LSN 510, 520 and 530. Figure 2-4 shows the structure of the Master TOC Area.

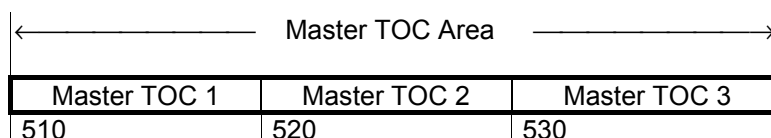


Figure 2-4 : Structure of the Master TOC Area

2.2.3.1 Master TOC

The Master TOC has a fixed size of 10 Sectors. The content of the Master TOC is defined in chapter 3.1. Figure 2-5 shows the structure of the Master TOC.

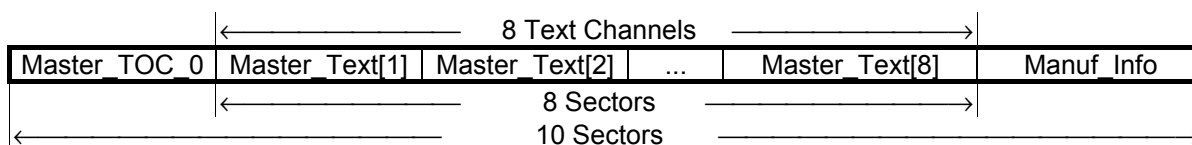


Figure 2-5 : Structure of the Master TOC

2.2.4 Audio Areas

An Audio Area contains two copies of the Area TOC and one Track Area. The Area TOC contains control information for the Audio Area. The Track Area contains the Tracks with audio information.

The audio information is stored in Audio Tracks. All 2-Channel Stereo Tracks are grouped in the 2-Channel Stereo Area. All Multi Channel Tracks are grouped in the Multi Channel Area. Each Audio Area contains Area TOC-1, a Track Area with Audio Tracks, and Area TOC-2.

Gaps between the Track Area and both Area TOC-1 and Area TOC-2 are allowed. The content of all Sectors in the gaps must be set to zero.

It is recommended to start Area TOC-1, Track Area and Area TOC-2 on an ECC boundary. If a 2-Channel Stereo Area is present, the 2-Channel Stereo Area must start at LSN 544. If a 2-Channel Stereo Area is not present, the Multi Channel Area must start at LSN 544.

The structure of an Audio Area is given in Figure 2-6.

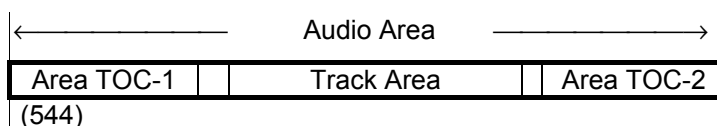


Figure 2-6 : Structure of an Audio Area

2.2.4.1 Area TOC

Two identical copies of the Area TOC are stored in Area TOC-1 and in Area TOC-2. The start location and length of Area TOC-1 and Area TOC-2 is for each Audio Area given in the Master TOC, see chapter 3.1.1.3. The content of the Area TOC is defined in chapter 3.2. Figure 2-7 shows the structure of the Area TOC.

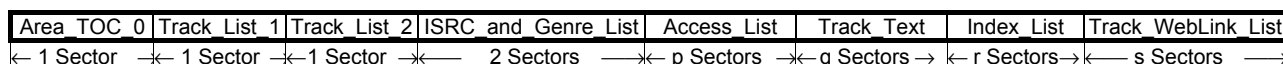


Figure 2-7 : Structure of the Area TOC

Area_TOC_0, Track_List_1, Track_List_2 and ISRC_and_Genre_List must always be present in an Area TOC. The presence of Track_Text, Index_List and Track_WebLink_List is optional. If Track_Text and/or Index_List and/or Track_WebLink_List are present in an Area TOC, Area_TOC_0 contains pointers to Track_Text and/or Index_List and/or Track_WebLink_List. Access_List must only be present if an Audio Area is DST coded (see chapter 3.2.1.2.3.1). The values of p, q, r and s are given in chapter 3.2.

2.2.4.2 Track Area

The start and end position of a Track Area are given in the Area TOC for that Audio Area (see chapters 3.2.1.2.12 and 3.2.1.2.13). The last sector of the Track Area is the last sector used by the last Track of that Track Area. Maximum 255 Tracks are allowed in a Track Area. The layout of a Track Area is given in Figure 2-8.

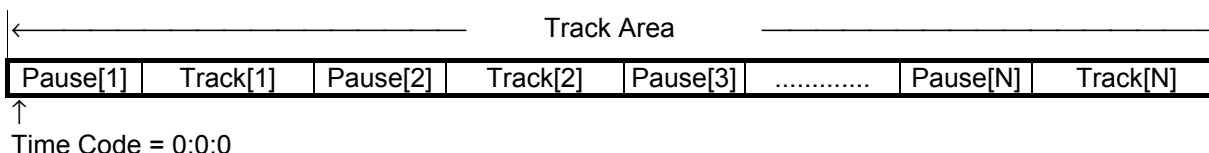


Figure 2-8 : Layout of the Track Area

For each Track, the start location, length and other information is given in the Area TOC (see chapter 3.2) of the Audio Area where the Track belongs to.

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2.2.4.2.1 Time Code

The Track Area contains a Time Code. The Time Code starts with zero (0:0:0) at the start of Pause[1]. The Time Code increments in steps of 1/75 Second to the end of the Track Area. A time unity of 1/75 Second is called a Frame. The Time Code is encoded in the Multiplexed Frames, see chapter 5.3.1.1.5.1.

2.2.4.2.2 Track

All Tracks in a Track Area are consecutively numbered starting with one. It is not allowed for Tracks to overlap. However, the first Frame of a Track can be located in a Sector that contains the end of the last Frame of the previous Track. The minimum length of a Track is 1 Second. A Track is subdivided into Indexes, see Figure 2-9.

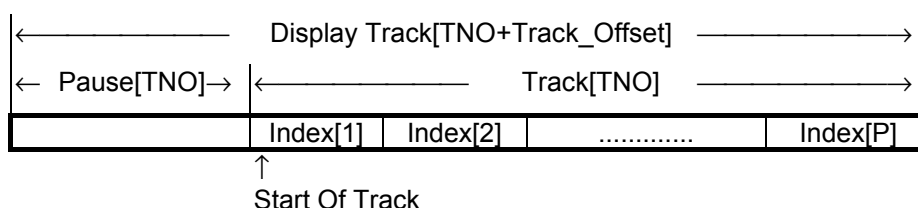


Figure 2-9 : Layout of a Track

Start Of Track for Track[TNO] is the Track_Start_Time_Code[TNO] as defined in Track_List_2 of the Area TOC, see chapter 3.2.3.

Note: Pause[TNO] is not encoded as Index[0].

2.2.4.2.2.1 Index

The first Index in a Track is Index[1]. Indexes must be numbered consecutively to the end of the Track. Maximum 255 Indexes are allowed per Track. The start of Index[1] is equal to the start of the Track. For Index[2] and following Indexes, the start Time Code is given in the Area TOC, see chapter 3.2.7. The minimum length of an Index is 1 Frame.

2.2.4.2.3 Pause

Each Track is preceded by a Pause. The Pause area that precedes Track[i] is called Pause[i]. The minimum length of a Pause is zero Seconds.

2.2.4.2.4 Display Time

It is recommended that an SACD player calculates a Time Code relative to the Start Of Track (see Figure 2-9), for display purposes.

2.2.4.2.5 Display Track

It is recommended that the Track Number displayed by an SACD player is equal to the value of TNO+Track_Offset (see chapter 3.2.1.2.10), from the start of Pause[TNO] to the end of Track[TNO].

2.2.4.2.6 General Audio Encoding

Depending on the Area, the encoded audio information in the Audio Tracks and in the preceding Pauses can be either Plain DSD, or DST coded DSD. The data in the Audio Tracks and Pauses will be multiplexed with Supplementary Data.

The audio information in the 2-Channel Stereo Area can be either Plain DSD or DST coded DSD. The audio information in the Multi Channel Area must be DST coded DSD.

The multiplexed audio information in an Area with Plain DSD has a Constant Byte Rate. The multiplexed audio information in an Area with DST coded DSD has a Variable Byte Rate.

3. TOC structure

The TOC of the high density layer has a two level structure, the highest level is the Master TOC, (see chapter 3.1) and the lower level is formed by the Area TOC (see chapter 3.2). The Master TOC contains album information and disc information. The Area TOC contains area information and track information. The Extra Data Area does not contain an Area TOC.

3.1 Master TOC

The Master TOC has a fixed length of 10 Sectors. The first Sector of the Master TOC is called Master_TOC_0. Master_TOC_0 contains general information on the disc, such as the size and location of the Audio Areas, album information, disc catalog number, disc genre and disc date.

Master_TOC_0 is followed by eight Sectors with maximum eight Text Channels that contain general information on the disc. For each Text Channel a language code and a character set code is defined in Master_TOC_0.

The syntax of the Master TOC is defined in Figure 3-1.

	# bytes	format
Master_TOC() {		
Master_TOC_0()	2048	Master_TOC_0
for (c=1; c<=8; c++)		
{		
Master_Text() [c]	2048	Master_Text
}		
Manuf_Info()	2048	Manuf_Info
}		

Figure 3-1 : Syntax of the Master TOC

3.1.1 Master_TOC_0

The syntax of Master_TOC_0 is defined in Figure 3-2.

	# bytes	format	value
Master_TOC_0() {			
M_TOC_0_Header()	16	M_TOC_0_Header	
Album_Info()	48	Album_Info	
Disc_Info()	64	Disc_Info	
Text_Channels()	40	Text_Channels	
Disc_WebLink_Info	128	Disc_WebLink_Info	
Reserved	until 2048	UInt8	0
}			

Figure 3-2 : Syntax of Master_TOC_0

3.1.1.1 M_TOC_0_Header

The syntax of M_TOC_0_Header is defined in Figure 3-3.

	# bytes	format	value
M_TOC_0_Header() {			
Master_TOC_Signature	8	String	"SACDMTOC"
Spec_Version	2	Spec_Version	
Reserved	6	UInt8	0
}			

Figure 3-3 : Syntax of Master_TOC_0_Header

3.1.1.1.1 Master_TOC_Signature

Master_TOC_Signature is an 8 byte string identifying the Master TOC. The value of Master_TOC_Signature must be "SACDMTOC" (\$53 \$41 \$43 \$44 \$4D \$54 \$4F \$43).

3.1.1.3.6 2CH_TOC_Length

2CH_TOC_Length must contain the length in Sectors of the Area TOC in the 2-Channel Stereo Area. If the 2-Channel Stereo Area is not present, the value of 2CH_TOC_Length must be zero.

3.1.1.3.7 MC_TOC_Length

MC_TOC_Length must contain the length in Sectors of the Area TOC in the Multi Channel Area. If the Multi Channel Area is not present, the value of MC_TOC_Length must be zero.

3.1.1.3.8 Disc_Catalog_Number

Disc_Catalog_Number is a 16 byte String that uniquely identifies each disc in an Album. The string is padded at the end with space characters (\$20). If a Disc_Catalog_Number is not used, all bytes must be set to zero.

3.1.1.3.9 Disc_Genre

The syntax of Disc_Genre is defined in chapter 1.7.2.3. Disc_Genre contains minimum zero and maximum four genres associated with this SACD disc.

3.1.1.3.10 Disc_Date

Disc_Date contains the creation date of the disc. For the encoding of Disc_Date, see chapter 1.7.2.1. If Disc_Date is not used, all fields of Disc_Date must be set to zero.

3.1.1.4 Text_Channels

Text_Channels contains the definition of the Text Channels used in the Master TOC. All text in Master_Text[c] must be according to the definitions in Text_Channels for Text Channel c. For the definition of Text_Channels, see chapter 1.7.2.8.

3.1.1.5 Disc_WebLink_Info

The syntax of Disc_WebLink_Info is defined in Figure 3-7.

	# bytes	format	value
Disc_WebLink_Info() {			
Disc_WebLink	n	WebLink_String	
Reserved	128-n	UInt8	0
}			

Figure 3-7 : Syntax of Disc_WebLink_Info

3.1.1.5.1 Disc_WebLink

Disc_WebLink contains a WebLink_String (see chapter 1.7.2.11) that points to a web page with information about this disc.

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3.1.2 Master_Text

Master_Text[c] contains all general text information that is related with the Album and with the Disc, for Text Channel c. Every Text Channel has an associated Master Text structure. The syntax of Master_Text is defined in Figure 3-8. The size of Master_Text is one Sector. For all Master_Text[c] with c>N_Text_Channels (see chapter 3.1.1.4 and chapter 1.7.2.8), all fields of Master_Text[c], except Master_Text_Signature, must be set to zero.

	# bytes	format	value
Master_Text() [c] {			
Master_Text_Signature	8	String	"SACDText "
Reserved	8	UInt8	0
Album_Title_Ptr	2	UInt16	
Album_Artist_Ptr	2	UInt16	
Album_Publisher_Ptr	2	UInt16	
Album_Copyright_Ptr	2	UInt16	
Album_Title_Phonetic_Ptr	2	UInt16	
Album_Artist_Phonetic_Ptr	2	UInt16	
Album_Publisher_Phonetic_Ptr	2	UInt16	
Album_Copyright_Phonetic_Ptr	2	UInt16	
Disc_Title_Ptr	2	UInt16	
Disc_Artist_Ptr	2	UInt16	
Disc_Publisher_Ptr	2	UInt16	
Disc_Copyright_Ptr	2	UInt16	
Disc_Title_Phonetic_Ptr	2	UInt16	
Disc_Artist_Phonetic_Ptr	2	UInt16	
Disc_Publisher_Phonetic_Ptr	2	UInt16	
Disc_Copyright_Phonetic_Ptr	2	UInt16	
Reserved	16	UInt8	0
if (Album_Title_Ptr!=0)			
{ Album_Title		Special_String }	
if (Album_Artist_Ptr!=0)			
{ Album_Artist		Special_String }	
if (Album_Publisher_Ptr!=0)			
{ Album_Publisher		Special_String }	
if (Album_Copyright_Ptr!=0)			
{ Album_Copyright		Special_String }	
if (Album_Title_Phonetic_Ptr!=0)			
{ Album_Title_Phonetic		Special_String }	
if (Album_Artist_Phonetic_Ptr!=0)			
{ Album_Artist_Phonetic		Special_String }	
if (Album_Publisher_Phonetic_Ptr!=0)			
{ Album_Publisher_Phonetic		Special_String }	
if (Album_Copyright_Phonetic_Ptr!=0)			
{ Album_Copyright_Phonetic		Special_String }	
if (Disc_Title_Ptr!=0)			
{ Disc_Title		Special_String }	
if (Disc_Artist_Ptr!=0)			
{ Disc_Artist		Special_String }	
if (Disc_Publisher_Ptr!=0)			
{ Disc_Publisher		Special_String }	
if (Disc_Copyright_Ptr!=0)			
{ Disc_Copyright		Special_String }	
if (Disc_Title_Phonetic_Ptr!=0)			
{ Disc_Title_Phonetic		Special_String }	
if (Disc_Artist_Phonetic_Ptr!=0)			
{ Disc_Artist_Phonetic		Special_String }	
if (Disc_Publisher_Phonetic_Ptr!=0)			
{ Disc_Publisher_Phonetic		Special_String }	
if (Disc_Copyright_Phonetic_Ptr!=0)			
{ Disc_Copyright_Phonetic		Special_String }	
Reserved	Until 2048	UInt8	0
}			

Figure 3-8 : Syntax of Master_Text

It is recommended that all discs in one Album contain the same Album related text. If Album_Set_Size (see chapter 3.1.1.2.1) is equal to one, it is recommended that the Album related text is equal to the Disc related text.

3.1.2.1 Master_Text_Signature

Master Text Signature is an 8 byte string identifying the text sectors of the Master TOC. The value of Master_Text_Signature must be "SACDText" (\$53 \$41 \$43 \$44 \$54 \$65 \$78 \$74). All eight Master_Text Sectors must have a Master_Text_Signature.

3.1.2.2 Album_Title_Ptr

Album_Title_Ptr contains a pointer to Album_Title. The pointer value is the byte position in the Sector of the first character of Album_Title. If Album_Title is not used, the Album_Title field is not present and Album_Title_Ptr must be set to zero. If Album_Title is used, the Album_Title field is present and Album_Title_Ptr must have the value 64.

3.1.2.3 Album_Artist_Ptr

Album_Artist_Ptr contains a pointer to Album_Artist. The pointer value is the byte position in the Sector of the first character of Album_Artist. If Album_Artist is not used, the Album_Artist field is not present and Album_Artist_Ptr must be set to zero.

3.1.2.4 Album_Publisher_Ptr

Album_Publisher_Ptr contains a pointer to Album_Publisher. The pointer value is the byte position in the Sector of the first character of Album_Publisher. If Album_Publisher is not used, the Album_Publisher field is not present and Album_Publisher_Ptr must be set to zero.

3.1.2.5 Album_Copyright_Ptr

Album_Copyright_Ptr contains a pointer to Album_Copyright. The pointer value is the byte position in the Sector of the first character of Album_Copyright. If Album_Copyright is not used, the Album_Copyright field is not present and Album_Copyright_Ptr must be set to zero.

3.1.2.6 Album_Title_Phonetic_Ptr

Album_Title_Phonetic_Ptr contains a pointer to Album_Title_Phonetic. The pointer value is the byte position in the Sector of the first character of Album_Title_Phonetic. If Album_Title_Phonetic is not used, the Album_Title_Phonetic field is not present and Album_Title_Phonetic_Ptr must be set to zero.

3.1.2.7 Album_Artist_Phonetic_Ptr

Album_Artist_Phonetic_Ptr contains a pointer to Album_Artist_Phonetic. The pointer value is the byte position in the Sector of the first character of Album_Artist_Phonetic. If Album_Artist_Phonetic is not used, the Album_Artist_Phonetic field is not present and Album_Artist_Phonetic_Ptr must be set to zero.

3.1.2.8 Album_Publisher_Phonetic_Ptr

Album_Publisher_Phonetic_Ptr contains a pointer to Album_Publisher_Phonetic. The pointer value is the byte position in the Sector of the first character of Album_Publisher_Phonetic. If Album_Publisher_Phonetic is not used, the Album_Publisher_Phonetic field is not present and Album_Publisher_Phonetic_Ptr must be set to zero.

3.1.2.9 Album_Copyright_Phonetic_Ptr

Album_Copyright_Phonetic_Ptr contains a pointer to Album_Copyright_Phonetic. The pointer value is the byte position in the Sector of the first character of Album_Copyright_Phonetic. If Album_Copyright_Phonetic is not used, the Album_Copyright_Phonetic field is not present and Album_Copyright_Phonetic_Ptr must be set to zero.

3.2 Area TOC

Two copies of the Area TOC are stored at the start and at the end of an Audio Area. The start location of each Area TOC is given in the Master TOC (see chapter 3.1.1.3). The Area TOC contains information on the Tracks in the Audio Area. The syntax of Area TOC is defined in Figure 3-10.

	# bytes	format	Mandatory/ Optional
Area_TOC() {			
Area_TOC_0()	2048	Area_TOC_0	M
Track_List_1()	2048	Track_List_1	M
Track_List_2()	2048	Track_List_2	M
ISRC_and_Genre_List()	2*2048	ISRC_and_Genre_List	M
Access_List()	0 or 32*2048	Access_List	-/M
Track_Text()	q*2048	Track_Text	O
Index_List()	r*2048	Index_List	O
Track_WebLink_List	s*2048	Track_WebLink_List	O
}			

Figure 3-10 : Syntax of Area TOC

If the Audio Area is DST coded, the Access_List must be present. If the Audio Area is Plain DSD coded, the Access_List is not present. Access_List occupies zero or 32 Sectors, the value of p (see chapter 2.2.4.1) is equal to zero or 32. The fields Track_Text, Index_List and Track_WebLink_List are optional. The presence of Track_Text, Index_List and Track_WebLink_List is indicated in the List_Pointers field of Area_TOC_0. Track_Text occupies maximum 32 Sectors ($q \leq 32$). Index_List occupies maximum 10 Sectors ($r \leq 10$). Track_WebLink_List occupies maximum 4 Sectors ($s \leq 4$). If the Access_List is present, the Area TOC occupies minimum 37 Sectors. If the Access_List is not present, the Area TOC occupies minimum 5 Sectors. The maximum size of the Area TOC is 79 Sectors.

SACD Part 3 can define additional Lists at the end of the Area_TOC.

Track_List_1 contains access information. Track_List_2 contains Time Code information and Track attributes.

3.2.1 Area_TOC_0

The syntax of Area_TOC_0 is defined in Figure 3-11.

	# bytes	format	value
Area_TOC_0() {			
A_TOC_0_Header()	16	A_TOC_0_Header	
Area_Data()	112	Area_Data	
List_Pointers()	16	List_Pointers	
Area_Text()	1904	Area_Text	
}			

Figure 3-11 : Syntax of Area_TOC_0

3.2.1.1 A_TOC_0_Header

The syntax of A_TOC_0_Header is defined in Figure 3-12.

	# bytes	format	value
A_TOC_0_Header() {			
Area_TOC_Signature	8	String	"TWOCHTOC" or "MULCHTOC"
Spec_Version	2	Spec_Version	
Area_TOC_Length	2	Uint16	5..
Reserved	4	Uint8	0
}			

Figure 3-12 : Syntax of A_TOC_0_Header

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3.2.1.2.3.1 Frame_Format

Frame_Format defines the Frame structure used by the multiplexed audio signal, see chapter 5. The value of Frame_Format is defined in Figure 3-16.

Value	Meaning
0	DST coded. Flexible format, see chapter 5
1	Reserved
2	Fixed format. 2-Channel Stereo, Plain DSD, 3 Frames in 14 Sectors. See chapter 5
3	Fixed format. 2-Channel Stereo, Plain DSD, 3 Frames in 16 Sectors. See chapter 5
4..15	Reserved for future use

Figure 3-16 : Definition of Frame_Format

3.2.1.2.4 N_Channels

N_Channels contains the number of audio channels that are encoded in each Frame of the current Audio Area. N_Channels is equal to the maximum number of Audio Channels that are available in the current Audio Area. For the 2-Channel Stereo Area the value of N_Channels must be set to 2. For the Multi Channel Area the allowed values of N_Channels are 5 and 6.

The relation between N_Channels and the Audio Channel number is defined in chapters 3.2.1.2.4.1 to 3.2.1.2.4.3. Except for the LFE Channel, the Channel Mapping defined in chapters 3.2.1.2.4.1 to 3.2.1.2.4.3 refers to the loudspeaker positions as defined in ITU-R BS.775-1.

For the Audio Channel Numbers used in this chapter, see Channel_Nr in chapters 5.6.3.1 and 5.6.3.2.

3.2.1.2.4.1 Channel Mapping for a 2-Channel Stereo Area (N_Channels=2)

If N_Channels is equal to 2, the Channel Mapping is defined in Figure 3-17.

Audio Channel Number	Channel Mapping
1	Left
2	Right

Figure 3-17 : Definition of Channel Mapping for N_Channels = 2

3.2.1.2.4.2 Channel Mapping for a Multi Channel Area (N_Channels=5)

If N_Channels is equal to 5, the Channel Mapping is defined in Figure 3-18.

Audio Channel Number	Channel Mapping
1	Left
2	Right
3	Center
4	Left Surround
5	Right Surround

Figure 3-18 : Definition of Channel Mapping for N_Channels = 5

3.2.1.3 List_Pointers

List_Pointers contains pointers to various lists in the current Area TOC. The value of a pointer gives the Sector offset, from the first Sector of the Area_TOC, to the first Sector of a list. If an offset value is set to zero, the corresponding list is not present. The syntax of List_Pointers is defined Figure 3-26.

	# bytes	format	value
List_Pointers() {			
Track_Text_Ptr	2	Uint16	0, 5, 37
Index_List_Ptr	2	Uint16	
Access_List_Ptr	2	Uint16	0, 5
Track_WebLink_List_Ptr	2	Uint16	
Reserved	8	Uint8	0
}			

Figure 3-26 : Syntax of List_Pointers

SACD Part 3 can define additional pointers in the Reserved field of List_Pointers.

Note that the order of Track_Text, Index_List and Access_List in the Area TOC (see chapter 3.2) is different from the order of the corresponding pointers in List_Pointers.

3.2.1.3.1 Track_Text_Ptr

Track_Text_Ptr contains a relative pointer to the Sector position of Track_Text. The value Track_Text_Ptr is the offset in sectors from the start of the current Area_TOC. If the Track_Text is not present, Track_Text_Ptr must be set to zero. If N_Text_Channels (see chapter 3.2.1.2.14 and chapter 1.7.2.8) is zero, Track_Text is not present, and therefore Track_Text_Ptr must be set to zero. For the current version of the SACD Specification, the allowed values for Track_Text_Ptr are 0, 5 and 37.

3.2.1.3.2 Index_List_Ptr

Index_List_Ptr contains a relative pointer to the Sector position of Index_List. The value of Index_List_Ptr is the offset in sectors from the start of the current Area_TOC. The Index_List is only present if the Audio Area contains minimum one Track with two or more Indexes. If the Index_List is not present, Index_List_Ptr must be set to zero.

3.2.1.3.3 Access_List_Ptr

Access_List_Ptr contains a relative pointer to the Sector position of Access_List. The value of Access_List_Ptr is the offset in sectors from the start of the current Area_TOC. The Access_List must be present if the Audio Area is DST coded. If the current Audio Area is Plain DSD, the Access_List is not allowed to be present. If the Access_List is not present, Access_List_Ptr must be set to zero. For the current version of the SACD Specification, the allowed values for Access_List_Ptr are 0 and 5.

3.2.1.3.4 Track_WebLink_List_Ptr

Track_WebLink_List_Ptr contains a relative pointer to the Sector position of Track_WebLink_List. The value of Track_WebLink_List_Ptr is the offset in sectors from the start of the current Area_TOC. The Track_WebLink_List is only present if the Audio Area contains minimum one Track with a WebLink. If the Track_WebLink_List is not present, Track_WebLink_List_Ptr must be set to zero.

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3.2.1.4 Area_Text

Area_TOC_0 must always contain Area_Text. Area_Text can contain general text for the current Audio Area. All unused fields in Area_Text must be set to zero. The syntax of Area_Text is defined in Figure 3-27.

	# bytes	format	value
Area_Text() {			
for (c=1; c<=N_Text_Channels; c++)			
{			
Area_Description_Ptr[c]	2	Uint16	
Area_Copyright_Ptr[c]	2	Uint16	
Area_Description_Phonetic_Ptr[c]	2	Uint16	
Area_Copyright_Phonetic_Ptr[c]	2	Uint16	
}			
Reserved	until 208	Uint8	0
for (c=1; c<=N_Text_Channels; c++)			
{			
if (Area_Description_Ptr[c] != 0)			
{ Area_Description[c]		Special_String }	
if (Area_Copyright_Ptr[c] != 0)			
{ Area_Copyright[c]		Special_String }	
if (Area_Description_Phonetic_Ptr[c] != 0)			
{ Area_Description_Phonetic[c]		Special_String }	
if (Area_Copyright_Phonetic_Ptr[c] != 0)			
{ Area_Copyright_Phonetic[c]		Special_String }	
}			
Reserved	until 2048	Uint8	0
}			

Figure 3-27 : Syntax of Area_Text

The value of N_Text_Channels is encoded in Text_Channels of Area_Data, see chapter 3.2.1.2.14.

3.2.1.4.1 Area_Description_Ptr

Area_Description_Ptr[c] contains the byte position for the first byte of Area_Description for Text Channel c. If Area_Description[c] is not used, Area_Description[c] is not present and Area_Description_Ptr[c] must be set to zero.

3.2.1.4.2 Area_Copyright_Ptr

Area_Copyright_Ptr[c] contains the byte position for the first byte of Area_Copyright for Text Channel c. If Area_Copyright[c] is not used, Area_Copyright[c] is not present and Area_Copyright_Ptr[c] must be set to zero.

3.2.1.4.3 Area_Description_Phonetic_Ptr

Area_Description_Phonetic_Ptr[c] contains the byte position for the first byte of Area_Description_Phonetic for Text Channel c. If Area_Description_Phonetic[c] is not used, Area_Description_Phonetic[c] is not present and Area_Description_Phonetic_Ptr[c] must be set to zero.

3.2.1.4.4 Area_Copyright_Phonetic_Ptr

Area_Copyright_Phonetic_Ptr[c] contains the byte position for the first byte of Area_Copyright_Phonetic for Text Channel c. If Area_Copyright_Phonetic[c] is not used, Area_Copyright_Phonetic[c] is not present and Area_Copyright_Phonetic_Ptr[c] must be set to zero.

3.2.1.4.5 Area_Description

Area_Description[c] contains a description of the current Audio Area in Text Channel c. The character set and language code for Text Channel c is defined in Text_Channels of Area_Data, see chapter 3.2.1.2.14. The definition of Special_String is given in chapter 1.7.2.6.

3.2.1.4.6 Area_Copyright

Area_Copyright[c] contains copyright information of the current Audio Area in Text Channel c. The character set and language code for Text Channel c is defined in Text_Channels of Area_Data, see chapter 3.2.1.2.14. The definition of Special_String is given in chapter 1.7.2.6.

3.2.1.4.7 Area_Description_Phonetic

Area_Description_Phonetic[c] contains a phonetic description of the current Audio Area in Text Channel c. The character set and language code for Text Channel c is defined in Text_Channels of Area_Data, see chapter 3.2.1.2.14. The definition of Special_String is given in chapter 1.7.2.6.

3.2.1.4.8 Area_Copyright_Phonetic

Area_Copyright_Phonetic[c] contains phonetic copyright information of the current Audio Area in Text Channel c. The character set and language code for Text Channel c is defined in Text_Channels of Area_Data, see chapter 3.2.1.2.14. The definition of Special_String is given in chapter 1.7.2.6.

3.2.2 Track_List_1

Track_List_1 contains the start Sector address and length for all Tracks in the current Audio Area. Track_List_1 must always be present in an Area TOC. The length of Track_List_1 is always one Sector. The syntax of Track_List_1 is defined in Figure 3-28.

	# bytes	format	value
Track_List_1(){			
Track_List_1_Signature	8	String	"SACDTRL1"
for (tno=1; tno<=N_Tracks; tno++)			
{			
Track_Start_Address[tno]	4	UInt32	
}			
Reserved	until 1028	UInt8	0
for (tno=1; tno<=N_Tracks; tno++)			
{			
Track_Length[tno]	4	UInt32	
}			
Reserved	until 2048	UInt8	0
}			

Figure 3-28 : Syntax of Track_List_1

The value of N_Tracks is encoded in Area_Data of Area_TOC_0, see chapter 3.2.1.2.

3.2.2.1 Track_List_1_Signature

Track_List_1_Signature is an 8 byte string identifying the sector with Track_List_1. The value of Track_List_1_Signature must be "SACDTRL1" (\$53 \$41 \$43 \$44 \$54 \$52 \$4C \$31).

3.2.2.2 Track_Start_Address

Track_Start_Address[tno] contains the Logical Sector Number (LSN) for the first Sector of Track[tno]. The first Sector of Track[tno] is the Sector that contains the first byte of the first Multiplexed Frame of that Track. The Track_Start_Address of a Track must be in the Track Area (see chapter 2.2.4.2) of the corresponding Audio Area.

Note: For $1 \leq \text{tno} < N_Tracks$ the following equation must be true:

$$\text{Track_Start_Address}[\text{tno}+1] \geq \text{Track_Start_Address}[\text{tno}] + \text{Track_Length}[\text{tno}] - 1$$

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3.2.3.5.2 TMF1, TMF2, TMF3, TMF4

The Track mute flags TMF1[tno] .. TMF4[tno] indicate which Audio Channels are not available for Track[tno]. If an Audio Channel is not available for a Track, this Audio Channel must contain a Silence Pattern during the whole Track. If contents is available for an Audio Channel, the audio contents of this Audio Channel is not restricted.

If N_Channels is equal to 2, TMF1[tno], TMF2[tno], TMF3[tno] and TMF4[tno] all must be set to zero.

TMF1[tno] set to one indicates that audio contents is not available in Audio Channels 1 and 2.

TMF2[tno] set to one indicates that audio contents is not available in Audio Channels 4 and 5 (if N_Channels = 5) or in Audio Channels 5 and 6 (if N_Channels = 6).

If N_Channels is equal to 5 or 6, TMF3[tno] set to one indicates that audio contents is not available in Audio Channel 3.

If N_Channels is equal to 6, TMF4[tno] set to one indicates that audio contents is not available in Audio Channel 4. If N_Channels is equal to 5, TMF4[tno] must be set to zero.

Figure 3-33 gives an overview of the relation between N_Channels and TMF1, TMF2, TMF3, TMF4.

For the relation between Audio Channel Number and the loudspeaker position, see the Channel Mappings defined in chapter 3.2.1.2.4.

Field name	value	N_Channels = 6	N_Channels = 5	N_Channels = 2
TMF1	0	Channel 1 and Channel 2 are available	Channel 1 and Channel 2 are available	Channel 1 and Channel 2 are available
	1	Value not allowed	Value not allowed	Value not allowed
TMF3	0	Channel 3 is available	Channel 3 is available	Not used
	1	Channel 3 contains a Silence Pattern	Channel 3 contains a Silence Pattern	Value not allowed
TMF4	0	Channel 4 is available	Not used	Not used
	1	Channel 4 contains a Silence Pattern	Value not allowed	Value not allowed
TMF2	0	Channel 5 and Channel 6 are available	Channel 4 and Channel 5 are available	Not used
	1	Channel 5 and Channel 6 contain a Silence Pattern	Channel 4 and Channel 5 contain a Silence Pattern	Value not allowed

Figure 3-33 : Relation between N_Channels and TMF1, TMF2, TMF3 and TMF4

For the Multichannel Area the following restrictions shall apply:

- Channel 1 and Channel 2 are always available (TMF1 is always equal to zero)
- Minimally three Audio Channels are always available
- If N_Channels is equal to 6 and TMF4[tno] is equal to zero, minimally four Audio Channels are always available.

Note: It is recommended that the jacket of the disc contains information on the actual Audio Channels used if minimally one of TMF2[tno], TMF3[tno] or TMF4[tno] is equal to 1.

3.2.7.3 N_Stored_Indexes

N_Stored_Indexes[tno] contains the number of Indexes that is stored in the Index_List for Track[tno]. The minimum allowed value for N_Stored_Indexes is one. The maximum allowed value for N_Stored_Indexes is 254.

Note: N_Stored_Indexes is equal to the number of Indexes in a Track minus one.

3.2.7.4 Index_Start_TC

Index_Start_TC[tno][x+1] contains the start Time_Code for Index x+1 in Track[tno]. The start Time_Code is relative to the start of the Audio Area, see chapter 2.2.4.2.1. The start position of Index[1] is equal to the start position of Track[tno], and is not stored in the Index_List. The first stored Index_Start_TC points to the start of Index 2. The encoding of Time_Code is defined in chapter 1.7.2.9.

3.2.8 Track_WebLink_List

Track_WebLink_List is only allowed to be present if the Audio Area contains minimum one Track with a WebLink. The maximum length of Track_WebLink_List is 4 Sectors. The syntax of Track_WebLink_List is defined in Figure 3-43.

	# bytes	format	value
Track_WebLink_List() {			
Track_WebLink_List_Signature	8	String	"SACD_WLL"
for (tno=1; tno<=N_Tracks; tno++)			
{			
Track_WL_Start_Ptr[tno]	2	Uint16	
}			
Reserved	until 524	Uint8	0
for (tno=1; tno<=N_Tracks; tno++)			
{			
if (Track_WL_Start_Ptr[tno] != 0)			
{			
Track_WebLink[tno]		WebLink_String	
}			
}			
Reserved	until eos	Uint8	0
}			

Figure 3-43 : Syntax of Track_WebLink_List

The value of N_Tracks is encoded in Area_Data of Area_TOC_0, see chapter 3.2.1.2.

3.2.8.1 Track_WebLink_List_Signature

Track_WebLink_List_Signature is an 8 byte string identifying the sector with Index_List. The value of Track_WebLink_List_Signature must be "SACD_WLL" (\$53 \$41 \$43 \$44 \$5F \$57 \$4C \$4C).

3.2.8.2 Track_WL_Start_Ptr

Track_WL_Start_Ptr[tno] contains the byte offset from the first byte of Track_WebLink_List to Track_WebLink[tno]. If Track_WebLink_List is present, the first non zero Track_WL_Start_Ptr in Track_WebLink_List must have the value 524. If Track_WL_Start_Ptr[tno] is equal to zero, Track_WebLink[tno] is not present.

3.2.8.3 Track_WebLink

Track_WebLink[tno] contains a WebLink_String that points to a web page containing information about Track[tno]. If Disc_WebLink (see chapter 3.1.1.5.1) can not be used for Track[tno], Track_WebLink can contain a WebLink_String for Track[tno]. If Track_WebLink[tno] is not present, Disc_WebLink can be used for Track[tno].

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3.3 DTCP

The DTCP Area contains the DTCP_SRM_List. The First Sector of the DTCP Area is Sector 400. The length of the DTCP Area is 110 Sectors.

3.3.1 DTCP_SRM_List

DTCP_SRM_List contains information for full authentication as defined in the DTCP specification. The first byte of the DTCP_SRM_List is the first byte of Sector 400. If the DTCP_SRM_List is not present, all bytes of all Sectors in the DTCP Area must be set to zero. The definition of DTCP_SRM_List is given in Figure 3-44.

	# bytes	format	value
DTCP_SRM_List() {			
DTCP_SRM0_List_Signature	8	String	"SACDSRM0"
DTCP_SRM[0]		SRM0	
Reserved	Until 110*2048	UInt8	0
}			

Figure 3-44 : Definition of DTCP_SRM_List

3.3.1.1 DTCP_SRM0_List_Signature

DTCP_SRM0_List_Signature is an 8 byte string identifying the first sector of DTCP_SRM0_List. If DTCP_SRM[0] exists, the value of DTCP_SRM0_List_Signature must be "SACDSRM0" (\$53 \$41 \$43 \$44 \$53 \$52 \$4D \$30).

3.3.1.2 SRM0

The content of SRM0 is equal to the content of the SRM Type=0 as defined in the DTCP Specification.

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4.2 Root Directory

Required files in the ROOT directory are: MASTER1.TOC, MASTER2.TOC, MASTER3.TOC and SRM0.LST.

4.2.1 Files MASTER1.TOC, MASTER2.TOC and MASTER3.TOC

The files MASTER1.TOC, MASTER2.TOC and MASTER3.TOC each must contain a copy of the Master TOC, see chapters 2.2.3.1 and 3.1. MASTER1.TOC must start at LSN 510. The name of the file MASTER1.TOC must be "MASTER1.TOC". MASTER2.TOC must start at LSN 520. The length of the files MASTER1.TOC, MASTER2.TOC and MASTER3.TOC must be 20480 bytes each. The name of the file MASTER2.TOC must be "MASTER2.TOC". MASTER3.TOC must start at LSN 530. The name of the file MASTER3.TOC must be "MASTER3.TOC".

4.2.2 File SRM0.LST

The file SRM0.LST contains the DTCP_SRM_List as defined in chapter 3.3.1. SRM0.LST must start at LSN 400. The name of SRM0.LST must be "SRM0.LST". The length of the file SRM0.LST must be 110*2048 bytes.

4.3 Directory 2C_AUDIO

If and only if the 2-Channel Stereo Area (see chapter 2.2) is present on a SACD, the directory 2C_AUDIO must be present. The name of the 2C_AUDIO directory must be "2C_AUDIO". The required files in the 2C_AUDIO directory are: 2C_AREA1.TOC, 2C_AREA2.TOC, 2C_TAREA.2CH and a file TRACKnnn.2CH for each Track in the 2-Channel Stereo Area.

4.3.1 Files 2C_AREA1.TOC and 2C_AREA2.TOC

The files 2C_AREA1.TOC and 2C_AREA2.TOC each must contain a copy of the Area TOC for the 2-Channel Stereo Area, see chapters 2.2.4.1 and 3.2. The name of the file 2C_AREA1.TOC must be "2C_AREA1.TOC". The name of the file 2C_AREA2.TOC must be "2C_AREA2.TOC". 2C_AREA1.TOC must start at the first Sector of the 2-Channel Stereo Area. If the 2C_AUDIO directory is present, the 2-Channel Stereo Area must start at LSN 544. The length of each file 2C_AREA1.TOC and 2C_AREA2.TOC must be equal to 2048*2CH_TOC_Length (see chapter 3.1.1.3.6).

4.3.2 File 2C_TAREA.2CH

The file 2C_TAREA.2CH represents the Track Area of the 2-Channel Audio Area. The name of the file 2C_TAREA.2CH must be "2C_TAREA.2CH". The first Sector of 2C_TAREA.2CH must be equal to the Track_Area_Start_Address (see chapter 3.2.1.2.12) of the 2-Channel Stereo Area. The last Sector of 2C_TAREA.2CH must be equal to the Track_Area_End_Address (see chapter 3.2.1.2.13) of the 2-Channel Stereo Area. The length of the file 2C_TAREA.2CH must be a multiple of 2048 bytes.

4.3.3 Files TRACKnnn.2CH

The file TRACKnnn.2CH represents Track nnn in the 2-Channel Stereo Area, see chapter 2.2.4.2. The name of the files TRACKnnn.2CH must be "TRACKnnn.2CH", where "nnn" is the Track number of the represented Track, encoded in ISO 646 as a three digit decimal number with leading zeros. TRACKnnn.2CH starts at the Track_Start_Address[nnn] (see chapter 3.2.2.2) of the 2-Channel Stereo Area. The size in sectors of TRACKnnn.2CH must be equal to Track_Length[nnn] (see chapter 3.2.2.3) in the 2-Channel Stereo Area. The length of each TRACKnnn.2CH file must be a multiple of 2048 bytes. All files TRACKnnn.2CH overlap with the file 2C_TAREA.2CH.

4.4 Directory MC_AUDIO

If and only if the Multi Channel Area (see chapter 2.2) is present on a SACD, the directory MC_AUDIO must be present. The name of the MC_AUDIO directory must be "MC_AUDIO". The required files in the MC_AUDIO directory are: MC_AREA1.TOC, MC_AREA2.TOC, MC_TAREA.MCH and a file TRACKnnn.MCH for each Track in the Multi Channel Area.

5.6.3.2.7.3 Coded_Filter_Coef_Set

Coded_Filter_Coef_Set indicates whether the Prediction Filter coefficients are predicted and Rice coded. Coded_Filter_Coef_Set is set to zero if the Prediction Filter coefficients are stored directly. Coded_Filter_Coef_Set is set to one if the Prediction Filter coefficients are predicted and Rice coded.

The maximum number of bits permitted for a single Prediction Filter inside Filter_Coef_Sets is:

$$7+1+\text{Pred_Order[]}*9$$

where 7 counts the bits for Coded_Pred_Order, 1 counts the Coded_Filter_Coef_Set bit and the rest the Pred_Order[] coefficients of 9 bit each.

5.6.3.2.7.4 CC_Method

CC_Method is a 2 bit code that identifies the Coefficient Coding Method of the current Prediction Filter.

5.6.3.2.7.5 CCM

CCM is a 3 bit unsigned integer that contains the Coefficient Coding M parameter that is used for Rice decoding the coefficients of the current Prediction Filter. The minimum allowed value for CCM is zero. The maximum allowed value for CCM is 6.

5.6.3.2.7.6 RL_Bit

RL_Bit is used to retrieve the single bits of the run length code, that consists of zeros with a terminating one. The shortest run length code is '1'.

5.6.3.2.7.7 LSBs

CCM least significant bits of the absolute value of the predicted coefficient are read from the stream directly and are stored in LSBs.

5.6.3.2.7.8 Sign

Sign is a bit that indicates if the predicted coefficient is positive (Sign='0') or negative (Sign='1').

5.6.3.2.8 Probability_Tables

For each Segment in each Audio Channel, the decoder uses a Probability Table (Ptable). In case two or more probability tables are equal, the corresponding probability table entries may be available from the stream only once. The variables used in the syntax of Probability_Tables are:

- Ptable_Len[Ptable_Nr]
- P_One[Ptable_Nr][0.. Ptable_Len[Ptable_Nr]-1]

With Ptable_Nr = 0..Nr_Of_Ptables-1.

In Probability_Tables all probability table entries are encoded. Per probability table, the length of the table (= the number of entries) and the entries are encoded. The Ptable entries can be coded using simple linear prediction and Rice coding. The syntax of Probability_Tables is defined in Figure 5-39.

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	# bits	format
Probability_Tables() {		
for (Ptable_Nr=0; Ptable_Nr<Nr_Of_Ptables; Ptable_Nr++)		
{		
Coded_Ptable_Len	6	UiMsbfbf
Ptable_Len[Ptable_Nr] = Coded_Ptable_Len+1		
if (Ptable_Len[Ptable_Nr] == 1)		
{		
P_one[Ptable_Nr][0] = 128		
}		
else		
{		
Coded_Ptable	1	BsMsbfbf
if (Coded_Ptable==0)		
{		
for (Entry_Nr=0; Entry_Nr<Ptable_Len[Ptable_Nr];		
Entry_Nr++)		
{		
Coded_P_one	7	UiMsbfbf
P_one[Ptable_Nr][Entry_Nr] = Coded_P_one+1		
}		
}		
else		
{		
PC_Method	2	BsMsbfbf
for (Entry_Nr=0; Entry_Nr<PCPO; Entry_Nr++)		
{		
Coded_P_one	7	UiMsbfbf
P_one[Ptable_Nr][Entry_Nr] = Coded_P_one+1		
}		
PCM	3	UiMsbfbf
for (Entry_Nr=PCPO;Entry_Nr<Ptable_Len[Ptable_Nr];		
Entry_Nr++)		
{		
Run_Length=0		
do		
{		
RL_Bit	1	BsMsbfbf
if (RL_Bit==0)		
{		
Run_Length++		
}		
} while (RL_Bit==0)		
LSBs	0..4	UiMsbfbf
Delta = (Run_Length<<PCM)+LSBs		
if (Delta != 0)		
{		
Sign	1	BsMsbfbf
if (Sign==1)		
{		
Delta = - Delta		
}		
}		
P_one[Ptable_Nr][Entry_Nr] = Delta		
for (Tap_Nr=0; Tap_Nr<PCPO; Tap_Nr++)		
{		
P_one[Ptable_Nr][Entry_Nr] -=		
PCPC[Tap_Nr]*P_one[Ptable_Nr][Entry_Nr-Tap_Nr-1]		
}		
}		
}		
}		
}		
}		

Figure 5-39 : Syntax of Probability_Tables

Nr_Of_Ptables is the value calculated in Mapping, see chapter 5.6.3.2.5.

Ptable_Len[] is an array that contains the probability table length for each Ptable. Where $Ptable_Len[Ptable_Nr] = Coded_Ptable_Len + 1$, for $Ptable_Nr \in \{0..Nr_Of_Ptables-1\}$. The allowed range of Ptable length: $1 \leq Ptable_Len[Ptable_Nr] \leq 64$.

P_one[][] is a two-dimensional array that finally contains all entries of all probability tables. The first (left) index is the Ptable_Nr and ranges from 0 through Nr_Of_Ptables-1. The second (right) index is the entry number and ranges from 0 through Ptable_Len[Ptable_Nr]-1. Each entry of P_one[][] is in the range of 1 to 128, corresponding to a probability of 1/256 to 128/256 of the next error bit (bit E, See Figure C-1) being a one.

PCPO is the Ptable Coding Prediction Order (PCPO). The relation between PC_Method and PCPO is defined in Figure 5-40.

PC_Method	PCPO
'00'	1
'01'	2
'10'	3
'11'	Not used

Figure 5-40 : Relation between PC_Method and PCPO

The restriction $PCPO < Ptable_Len[Ptable_Nr]$ applies.

Run_Length is a help variable to count the number of zeros in the run length code that is part of the Rice code.

Delta is a help variable to calculate the Rice decoded Number.

PCPC[] is an array that contains the Ptable Coding Prediction Coefficients (PCPC) that are used for the linear prediction of the Ptable entries. The relation between PC_Method and PCPC[] is defined in Figure 5-41.

PC_Method	PCPC[0]	PCPC[1]	PCPC[2]
'00'	-1	-	-
'01'	-2	1	-
'10'	-3	3	-1
'11'	Not used	Not used	Not used

Figure 5-41 : Relation between PC_Method and PCPC[]

5.6.3.2.8.1 Coded_Ptable_Len

Coded_Ptable_Len is a 6 bit unsigned integer that contains the coded probability table length.

5.6.3.2.8.2 Coded_Ptable

Coded_Ptable indicates whether the Ptable entries are predicted and Rice coded. **Coded_Ptable** is set to zero if the Ptable entries are stored directly. **Coded_Ptable** is set to one if the Ptable entries are predicted and Rice coded.

The maximum number of bits permitted for a single Ptable inside Probability_Tables is:

$$6 + 1 + Ptable_Len[] * 7$$

where 6 counts the bits for Coded_Ptable_Len, 1 counts the Coded_Ptable bit and the rest the Ptable_Len[] coded Ptable entries of 7 bit each.

5.6.3.2.8.3 Coded_P_one

Coded_P_one is a 7 bit unsigned integer that contains the coded value of the next entry of the current Ptable.

Annex A: Play Back Requirements (Normative)

This Annex contains requirements for Super Audio CD players.

A.1 Player Reference Model

The global block diagram of a SACD Reference Player is given in Figure A-1. This description of the Super Audio CD player reference model consists of:

- SACD player block diagram
- Description of each block

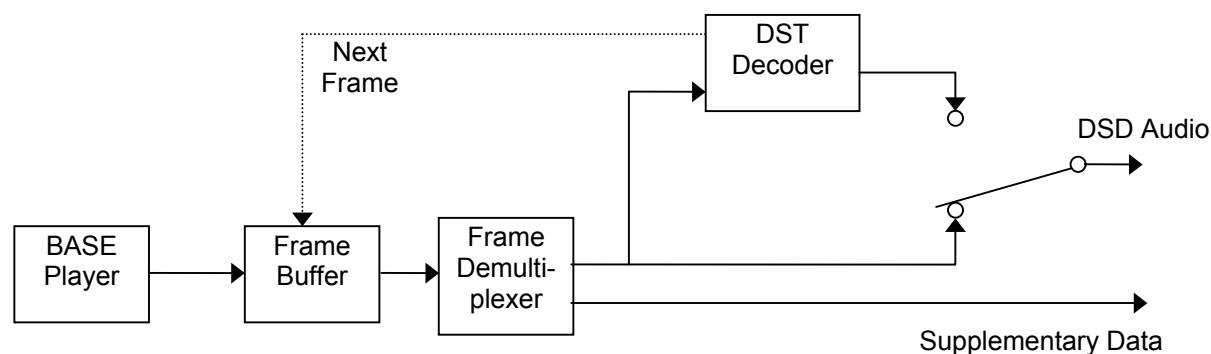


Figure A-1 : Global Block Diagram of the SACD Reference Player

BASE Player:

The BASE Player is responsible for functions like:

- Optical readout
- Servo Systems
- Demodulation
- Error Correction
- Delivering a stream of sectors with a constant rate.

Part 3

Every SACD player must fulfill the requirements defined in SACD Part 3.

Frame Buffer:

The Frame Buffer accumulates the disc data into Frames, which will be passed to the Frame Demultiplexer at a rate of 75 Frames per second.

Frame Demultiplexer:

The Frame Demultiplexer separates the Elementary Frames from a Multiplexed Frame.

DST Decoder:

The DST Decoder decodes the DST Coded Audio Frames into a Plain DSD Audio Stream.

Fade-in and fade-out times:

It is recommended that both the fade-in and the fade-out times of a SACD player are less than 50 mS.

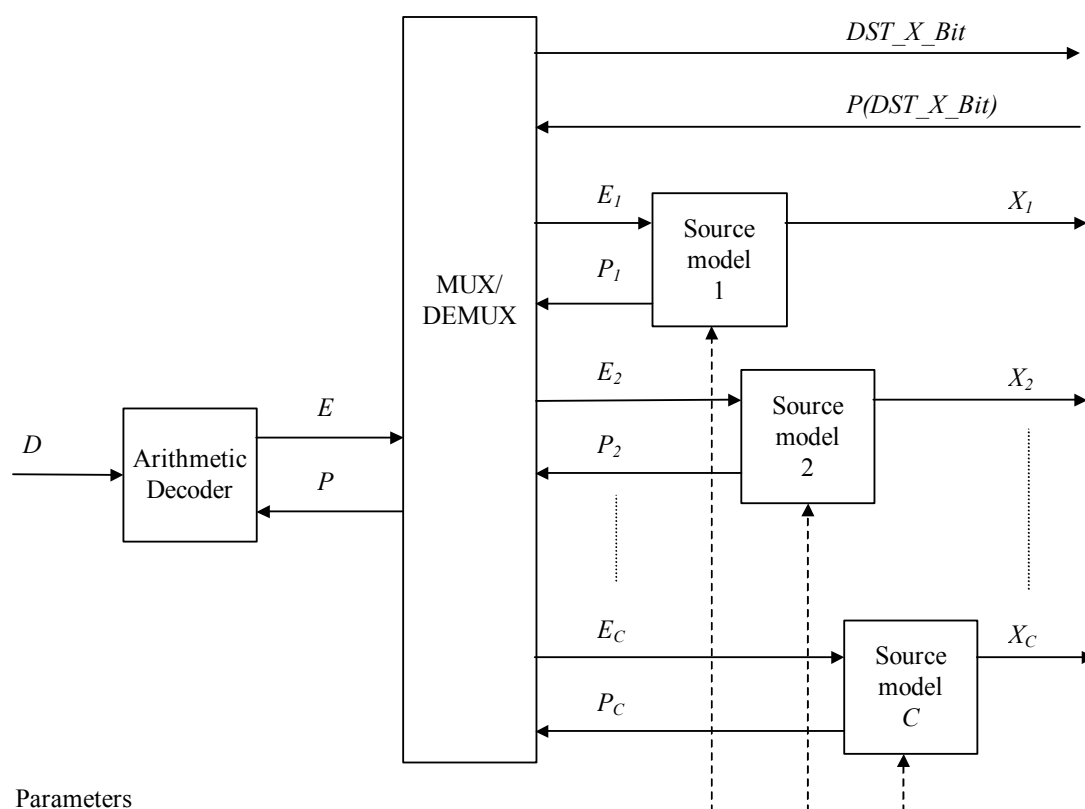


Figure C-3 : Global diagram of the C-channel DST decoder

C.2 DST Decoding Processes

The parameters processed and extracted from the stream are used to decode the DST coded frame. This chapter explains the decoding processes needed for DST coded frames.

C.2.1 Introduction

In Figure C-3, three functions are distinguished: the arithmetic decoder, the multiplexer/demultiplexer and a number of source models. The arithmetic decoder receives the sequence of bits ($D=A_Data$) and the sequence of probabilities (P) and generates the sequence of bits (E). The E and P sequences are assigned to the source models in a cyclic order that is controlled by the multiplexer/demultiplexer. Every source model receives the required parameters like prediction filter coefficients and probability table entries from the stream as specified in syntax and semantics.

Source model S corresponds with channel S . The output X of Source model S is the DSD signal for channel S .

C.2.2 Arithmetic Decoder

Arithmetic coding is a variable length coding technique to compress data near to its entropy. The coded data is represented as a number. The number uses as many digits as are required to uniquely identify the original data. For more information about arithmetic coding see:

- [1] I.H. Witten, R.M. Neal, and J.G. Cleary, "Arithmetic coding for data compression", Communications ACM, vol. 30, pp. 520-540, June 1987.
- [2] P.G. Howard, and J.S. Vitter, "Arithmetic coding for data compression", Proc. IEEE, vol. 82, no. 6, p. 857-65, June 1994.

Annex D: Audio Signal Requirements (Normative)

D.1 SACD Audio Level measuring condition

SACD Audio levels must be measured after a 50 kHz Butterworth 30 dB/Oct low pass filter.

D.2 SACD Zero dB Audio Reference Level

The SACD Zero dB Audio Reference Level, referred to as "0 dB SACD", corresponds to a sine wave with a peak amplitude equal to 50% of the theoretical maximum DSD signal level.

D.3 Maximum SACD Audio Peak Level

The maximum SACD audio peak level is determined by the maximum allowable DSD modulation level. The DSD Modulation Level is equal to $\frac{|28 - 2N|}{28}$, where N is the number of bits set to one within any 28 consecutive bits of the DSD stream, and $4 \leq N \leq 24$. The maximum allowed value of the DSD Modulation Level is 20/28. A DSD Modulation Level of 20/28 corresponds to the maximum SACD Audio Peak Level of +3.10 dB SACD. Peak signal levels above +3.10 dB SACD are not allowed.

D.4 High Frequency DSD Signal + Noise Level

The accumulated RMS signal + noise level of the DSD signal, measured after a 40 kHz Butterworth 30 dB/Oct high pass filter and a 100 kHz Butterworth 30dB/Oct low pass filter, is maximally equal to the RMS level of an input sinewave with a peak amplitude of -20 dB SACD (see D.2).

The averaging filter used to calculate the RMS level must be a first order unity gain IIR filter with a coefficient of $1/524288$ (2^{-19}), corresponding to an IIR filter with a cutoff frequency of about 0.85 Hz.

Annex E: Audio Signal Recommendations (Informative)

E.1 Analog Output Level

The recommended analog output level of a 1 kHz 0 dB SACD sine wave is 2 V RMS $\pm$ 1 dB. For a SACD player with CD-DA playback capability it is recommended that the analog CD-DA output of a fully modulated signal is equal to the analog SACD output for a 0 dB SACD signal.

Note: the maximum allowed peak signal level is +3.10 dB SACD, see D.3.

E.2 Analog Post-filter

To protect analog amplifiers and loudspeakers, it is recommended that a SACD player contain at its output an analog low pass filter with a cut-off frequency of maximum 50 kHz and a slope of minimum 30 dB/Oct. For use with wide-band audio equipment, filters with a cut-off frequency of over 50 kHz can be used.

E.3 DSD DC Offset

It is recommended that the DC Offset of the DSD signal on the disc is less than -50 dB SACD.

E.4 DSD polarity

It is recommended that a DSD bit equal to one translates into a rising output voltage at the output of a SACD player.

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List of Changes

Changes from “Super Audio CD System Description Part 2, Version 1.2” to “Super Audio CD System Description Part 2, Draft Version 1.3”

The main changes are:

- Optional WebLinks are added in the Master TOC and per Track in the Area TOC.
- A text type is added for copyright strings.
- An RMS averaging filter has been defined in Annex D.4.
- Annex E.2 about the HF DSD signal + noise peak level has been removed.
- Corrections and clarifications.

Unless stated otherwise, the chapter and figure numbers in the following list refer to the numbers found in Draft Version 1.3.

Chapter	Version 1.2	Draft Version 1.3	Remarks
1.3	UDF ... see http://www.osta.org	UDF ... see www.osta.org	Editorial.
1.3	DTCP ... See http://www.dtcp.com/ .	DTCP ... See www.dtcp.com .	Editorial.
1.4	DTCP Digital Transmission Content Protection, see www.dtcp.com .	DTCP Digital Transmission Content Protection Specification Version 1.2, (Information Version), Volume 1. See www.dtcp.com .	Clarification.
1.7.2.4	Minor_Version 1 20	Minor_Version 1 30	Version number change.
1.7.2.4	... and Minor_Version is equal to 20.	... and Minor_Version is equal to 30.	Version number change.
1.7.2.10.1	0 Not Used	0 Reserved	Clarification.
1.7.2.10.1	--	8 Copyright	Text_Type for copyright added.
1.7.2.10.1	128 Not Used	128 Reserved	Clarification.
1.7.2.10.1	--	136 Copyright, phonetic text	Text_Type for copyright added.
1.7.2.11	--	Weblink_String	Definition added.
2.2	The Volume Space of a SACD disc is split into: File System Area, Master TOC Area ...	The Volume Space of a SACD disc is split into: File System Area, DTCP Area, Master TOC Area ...	Clarification.
2.2.4.1 Fig 2-7	--	Track_WebLink_List s sectors	WebLink. List added to Area TOC.
2.2.4.1	The presence of Track_Text and Index_List is optional. If Track_Text and/or Index_List are present in an Area TOC, Area_TOC_0 contains pointers to Track_Text and/or to Index_List.	The presence of Track_Text, Index_List and Track_WebLink_List is optional. If Track_Text and/or Index_List and/or Track_WebLink_List are present in an Area TOC, Area_TOC_0 contains pointers to Track_Text and/or Index_List and/or Track_WebLink_List.	WebLink. List added to Area TOC.

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Chapter	Version 1.2	Draft Version 1.3	Remarks
2.2.4.1	The values of p, q and r are given ...	The values of p, q, r and s are given ...	WebLink. List added to Area TOC.
2.2.4.2.5	(see 3.2.1.2.10)	(see chapter 3.2.1.2.10)	Editorial.
3.1.1	--	Disc_WebLink_Info 128 Disc_WebLink_Info	WebLink added to Master TOC.
3.1.1.5	--	Disc_WebLink_Info ...	New chapter. WebLink added to Master TOC.
3.1.2	--	If Album_Set_Size (see chapter 3.1.1.2) is equal to one, it is recommended that the Album related text is equal to the Disc related text.	Recommendation added.
3.2 Fig 3-10	--	Track_WebLink_List s*2048 Track_WebLink_List O	WebLink. List added to Area TOC.
3.2	The fields Track_Text and Index_List are optional.	The fields Track_Text, Index_List and Track_WebLink_List are optional.	WebLink. List added to Area TOC.
3.2	The presence of Track_Text and Index_List is indicated ...	The presence of Track_Text, Index_List and Track_WebLink_List is indicated ...	WebLink. List added to Area TOC.
3.2	--	Track_WebLink_List occupies maximum 4 Sectors (s <= 4).	WebLink. List added to Area TOC.
3.2	The maximum size of the Area TOC is 80 Sectors.	The maximum size of the Area TOC is 79 Sectors.	Correction.
3.2.1.2.4	... defined in 3.2.1.2.4.1 to 3.2.1.2.4.3.	... defined in chapters 3.2.1.2.4.1 to 3.2.1.2.4.3.	Editorial
3.2.1.3 Fig 3-26	--	Track_WebLink_List_Ptr 2 Uint16	WebLink. List added to Area TOC.
3.2.1.3.4	--	Track_WebLink_List_Ptr	WebLink. Chapter added. List added to Area TOC.
3.2.1.4 Fig 3-27	Area_Name_Ptr Area_Name_Phonetic_Ptr Area_Name Area_Name_Phonetic	Area_Description_Ptr Area_Description_Phonetic_Ptr Area_Description Area_Description_Phonetic	Name change. Clarification.
3.2.1.4.1	Area_Name_Ptr Area_Name	Area_Description_Ptr Area_Description	Name change. Clarification.
3.2.1.4.3	Area_Name_Phonetic_Ptr Area_Name_Phonetic	Area_Description_Phonetic_Ptr Area_Description_Phonetic	Name change. Clarification.
3.2.1.4.5	Area_Name	Area_Description	Name change. Clarification.
3.2.1.4.5	contains the name of the current	contains a description of the current	Name change. Clarification.
3.2.1.4.7	Area_Name_Phonetic	Area_Description_Phonetic	Name change. Clarification.
3.2.1.4.7	contains the phonetic name of the current	contains a phonetic description of the current	Name change. Clarification.

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Chapter	Version 1.2	Draft Version 1.3	Remarks
3.2.3.5.2	... see the Channel Mappings defined in 3.2.1.2.4.	... see the Channel Mappings defined in chapter 3.2.1.2.4.	Editorial.
3.2.3.5.2 Fig 3-33	Channel 1 and Channel 2 contain a Silence Pattern	Value not allowed	Correction. TMF1 at N_Channels equal to 5 and 6.
3.2.3.5.2	If N_Channels is equal to 5, minimally one of TMF1[tno], TMF2[tno], TMF3[tno] must be equal to zero. If N_Channels is equal to 6, minimally one of TMF1[tno], TMF2[tno], TMF3[tno], TMF4[tno] must be equal to zero.	--	Clarification.
3.2.3.5.2	if minimally one of TMF1[tno], TMF2[tno], TMF3[tno] or TMF4[tno] is equal to 1.	if minimally one of TMF2[tno], TMF3[tno] or TMF4[tno] is equal to 1.	Correction.
3.2.8	--	Track_WebLink_List ...	WebLink. New chapter. List added to Area TOC.
3.3.1.2	as defined in the DTCP Specification Version 1.1 Volume 1.	as defined in the DTCP Specification.	Editorial. Definition moved to chapter 1.4.
4.2.2	as defined in 3.3.1	as defined in chapter 3.3.1	Editorial.
5.6.3.2.8	... calculated in Mapping, see 5.6.3.2.5.	... calculated in Mapping, see chapter 5.6.3.2.5.	Editorial.
A.1	--	The global block diagram of a SACD Reference Player is given in Figure A-1.	Editorial.
Annex B Fig B-1	0 Not Used	0 Reserved	Clarification.
Annex C.2.1	model S corresponds with channel S+1. The output X of Source model S is the DSD signal for channel S+1.	model S corresponds with channel S. The output X of Source model S is the DSD signal for channel S.	Correction.
Annex D.2	The SACD Zero dB Audio Reference Level corresponds to a sine wave with a peak level equal to 50% of the theoretical maximum DSD signal level, this level is referred to as "0 dB SACD".	The SACD Zero dB Audio Reference Level, referred to as "0 dB SACD", corresponds to a sine wave with a peak amplitude equal to 50% of the theoretical maximum DSD signal level.	Clarification.
Annex D.4	The accumulated RMS signal + noise level of the DSD signal is maximum -20 dB SACD, measured after a 40 kHz Butterworth 30 dB/Oct high pass filter and a 100 kHz Butterworth 30dB/Oct low pass filter.	The accumulated RMS signal + noise level of the DSD signal, measured after a 40 kHz Butterworth 30 dB/Oct high pass filter and a 100 kHz Butterworth 30dB/Oct low pass filter, is maximally equal to the RMS level of an input sinewave with a peak amplitude of -20 dB SACD (see D.2).	Clarification.

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Chapter	Version 1.2	Draft Version 1.3	Remarks
Annex D.4	--	The averaging filter used to calculate the RMS level must be a first order unity gain IIR filter with a coefficient of $1/524288$ (2^{-19}), corresponding to an IIR filter with a cutoff frequency of about 0.85 Hz.	RMS filter specified.
Annex E.1	Analogue Output Level	Analog Output Level	Editorial.
Old Annex E.2	E.2 High Frequency DSD Signal + Noise Peak Level	--	Annex E.2 removed.